DIFFERENTIAL PSYCHOLOGICAL TEST PERFORMANCE OF CHILDREN WITH TOURETTE'S SYNDROME AND LEARNING DISABILITIES

By

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Dedicated to my wife Kathy,
and children, Richard, Philip, and Daniel,
who support my dreams and goals.

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Abstract of Dissertation Presented to the Graduate School
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DIFFERENTIAL PSYCHOLOGICAL TEST PERFORMANCE OF CHILDREN WITH TOURETTE'S SYNDROME AND LEARNING DISABILITIES

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The purpose of this study was to determine whether children with Tourette's Syndrome and children with learning disabilities showed characteristically different performance on the following measures: (1) general intellectual ability, as measured by the Wechsler Intelligence Scale for Children-Revised; (2) short-term memory for visual and auditory stimuli, as measured by the Visual Aural Digit Span Test; (3) receptive language, as measured by the Peabody Picture Vocabulary Test-Revised; (4) visual-motor skills, as measured by the Bender Visual-Motor Gestalt Test; and (5) academic achievement in the areas of reading, spelling, and arithmetic, as measured by the Wide Range Achievement Test.

The subjects were 25 children with Tourette's Syndrome (TS), as diagnosed by neurologists, and 25 children with learning disabilities (LD), as diagnosed by school psychologists, who were matched on the basis of age and ability level.

The results indicated that the TS group scored significantly higher on the Information, Vocabulary, and Block Design subtests of the WISC-R; in receptive language on the PPVT-R; and on the Reading and Spelling subtests of the WRAT. The TS group also scored significantly lower on the Coding subtest of the WISC-R.

Both the TS and LD groups showed similar weaknesses in mental and written arithmetic, short-term memory, and visual-motor skills. The TS group had difficulty with tasks requiring sustained attention, particularly for auditory information, or where visiographic abilities are required. Although the psychological tests used could not clearly differentiate TS from LD students, these tests did show that TS students show deficits in their performance.

Psychological examiners should become aware of the symptoms and typical performance of TS students. Although testing cannot alone discriminate between TS and LD students, awareness of these symptoms can allow the psychologist to make appropriate judgments and recommendations based upon clinical observations and test performance. Educators should understand typical strengths and weaknesses as well as the uniqueness of the particular

student in designing interventions to promote learning for both TS and LD students.

CHAPTER I

INTRODUCTION

Tourette's Syndrome represents a rare and complex tic syndrome characterized by an unusual and socially disabling pattern of behaviors. Gilles de la Tourette first described the syndrome in 1885, and it has become clear that the stable pattern of symptoms represent a discrete diagnostic category. Briefly, Tourette's Syndrome (TS) is characterized by motor and phonic tics, and is often accompanied by coprolalia, or vocal obscenities. Because the syndrome has received increased research attention in the past 20 years, recently there has been a dramatic increase in both the number of cases reported and the number of publications concerning TS.

The recent surge of interest in TS has led to increasing recognition of the syndrome and focus upon its identification and characteristics. In general, the research has focused upon treatment effectiveness as well as on the etiological and epidemiological characteristics of TS (Bruun, 1984; Bruun, Shapiro, Shapiro, Sweet, Wayne, & Solomon, 1976; O'Quinn & Thompson, 1980). Because of the socially disabling characteristics of the syndrome, organic (including drug) and psychological treatment studies have formed the major body of research. However, the unusual constellation of behaviors associated with TS presents an unclear etiology, which appears to be both functional and organic in nature (Baker, Platt, & Fine, 1983).

The prevalence of TS is estimated to be at 0.5 per thousand (Shapiro & Shapiro, 1982a), representing approximately 110,000 persons in the United States. However, the disorder is found in cultures throughout the world with a consistent pattern of expression (Abuzzahab & Anderson, 1973; Shapiro, Shapiro, Bruun, & Sweet, 1978).

For children affected with this disorder, the range and severity of symptoms varies widely. Generally, TS begins in childhood and involves motor tics, phonic symptoms, compulsions, and at times urges to echo or imitate (Jagger, Prusoff, Cohen, Kidd, Carbonair, & John, 1982). However, the history of each child also includes a waxing and waning course, as well as changing symptoms. In addition, symptoms may vary over the course of the day due to the effects of arousal, stress, or fatigue. Thus, research on TS has been difficult because of this altering pattern of symptoms.

The majority of TS patients are male, with a reported average age of onset of seven years (Shapiro & Shapiro, 1982a). The majority of these patients receive medications, and haloperidol is most frequently prescribed. Haloperidol generally provides a reduction of symptoms, but not without undesirable side effects. Many TS patients report lethargy, impaired functioning, and depression as side effects of haloperidol.

For TS patients, there appear to be no unusual prenatal or birth characteristics. In addition, developmental histories are, as a rule, unremarkable. However, classroom and learning difficulties were frequently cited in an epidemiological study by Jagger et al. (1982). Of a total of 75 respondents, over two-thirds (n=52) of the respondents noted that teachers had complained of listening and attention problems, and almost half (n=30) of the teachers reported that these TS patients were hard to control in the classroom. Over one-fourth (n=20) of those studied had been placed in special education classrooms.

Many TS children report significant difficulty with social relationships as a result of their unusual symptoms (i.e., vocal and motor tics, coprolalia). For example, these children are often teased by other classmates about their symptoms. The symptoms associated with TS thus represent significant difficulties for the child in the classroom. Unfortunately, learning as well as social difficulties increase stress, leading to an increase in symptoms. Family and sibling relations may also be affected. For example, the majority of TS subjects in the Jagger study reported that they had seen a mental health professional for emotional or psychological problems.

A study by Hagin, Beecher, Pagona, and Kreeger (1982) examined the learning difficulties which TS students exhibit within the classroom. They concluded that TS students "have difficulty demonstrating their skills on measures requiring independent reading or on tasks requiring sustained handwriting, such as mathematics computation or written language" (p. 327). In addition, the authors pointed out that the TS children had generalized problems in focusing attention on salient stimuli and in sustaining responses over an extended period of time. They concluded that although TS children may have adequate educational abilities, they have difficulty in communicating what they have learned. Because of these apparent educational difficulties, TS children may appear to have learning disabilities, and associated symptoms may be attributed to stress or emotional problems.

The study of TS presents a dichotomy of organic and functional factors. Cohen and Leckman (1984), however, presented a balanced view:

> TS probably represents the best example of a childhood neuropsychiatric disorder in which genetic and environmental factors can be seen to operate over the course of development - in which neurochemical factors appear to mediate between biological diathesis and symptomatology, in which various types of phenomena (from simple tics to compulsions and obsessions) relate to underlying pathobiology, in which environmental and state factors modify expression, and in which research has led to new treatment. (p. 124)

Historically, a wide variety of TS treatment methodologies have been attempted, including organic and psychotherapeutic approaches. Psychotherapy and behavior modification procedures have met with modest results. Some researchers report successful treatment with functional approaches, although these reports are difficult to interpret because of small samples (e.g., case studies), combinations of treatments (e.g., drug therapy combined with psychotherapy), and the characteristic changing course of symptoms (Baker, Platt, & Fine, 1983).

Statement of the Problem

The problem addressed in this study was whether TS students demonstrate an identifiable performance pattern on commonly used psychological tests, and whether this performance pattern could differentiate TS students from learning-disabled (LD) students. The need for studies to define the psychological and educational performance of TS students has been emphasized by many primary TS researchers (e.g., Harcherik, Carbonair, Shaywitz, Shaywitz, & Cohen, 1982; Shapiro & Shapiro, 1982b; Sutherland, Kolb, Schoel, Whishaw, & Davies, 1982). Thus, the objective of this study was to determine the performance pattern of TS children in comparison to children with learning disabilities on a variety of measures commonly used by school psychologists.

Children with TS often have apparent learning difficulties within the classroom. This study attempted to demonstrate such a pattern of psychological and educational abilities and deficits through the use of standardized psychological tests. Results from this study, therefore, are of potential aid in the early identification of TS children and also in their differentiation from LD children. Because TS students often have learning difficulties, they may be referred to a school psychologist. TS is a syndrome with a progressive pattern of symptoms, and may not be easily identifiable in its early stages. TS has generally been associated with coprolalia, or vocal obscenities. However, this symptom generally occurs later in the course of the syndrome, and only occurs in a reported 37% of cases (Jagger et al., 1982). Consequently, the school psychologist might dismiss the symptoms, such as tics of the head or throat clearing, as manifestations of stress due to learning difficulties.

Previously, standardized psychological test batteries have yielded conflicting results when used with TS children. Therefore, the current study attempted to identify a performance pattern on psychological and educational tests which would represent the TS student, and to determine whether these tests could discriminate between TS and LD students.

Need for the Study

If it were known that a clear pattern of psychological and educational test performance existed for TS children, this knowledge would yield significant implications for the study of TS. Specifically, these implications would be in the areas of theory, research, practice, and training. From a theoretical perspective, the presence of an identifiable performance pattern of abilities and deficits could assist in theoretical formulations concerning the etiology of TS, and its relationship to other, similar disorders. The absence of a clear performance pattern of TS could lend support to a functional etiology based upon environmental conditions and learning theory. The performance of TS children on psychological tests thus provides information useful in the development of hypotheses about central nervous system impairment, and the localization of this impairment.

These theoretical implications lead directly to further research questions. The existence or absence of a clearly differentiated performance pattern could suggest future research utilizing or emphasizing tests with greater ability to discriminate between TS and LD students. In addition, a delineation of impairment could direct researchers into the development of remediation approaches to benefit children with TS.

Epidemiological evidence exists that a large portion of TS subjects have learning difficulties. Jagger et al. (1982) found that 53% of the TS subjects in their study reported that the disorder at least moderately affected their school performance. A consistent pattern of performance could provide a basis for understanding the syndrome, leading to the development of effective learning strategies. In the formal assessment of children, individual differences and unusual profiles of abilities and dysfunction form the basis of understanding and the formation of effective remediations. Group profiles can also provide important information to establish the clinical validity of a battery of instruments as well as to localize any pattern of impairment which may be present.

Since TS students often have learning difficulties, school psychologists and mental health practitioners could use the results of this study to assist in the differentiation of TS students from LD students. As noted earlier, coprolalia is a widely known characteristic of TS, but it typically occurs later in the progression of symptoms, and sometimes it does not occur at all. An identifiable performance pattern of TS students could, therefore, better assist the school psychologist in differentiating TS from LD students.

The results of the current study also have significant implications for training. If it were known that a consistent profile of learning abilities and deficits existed in the TS student population, school and mental health professionals could be trained in the early identification of the syndrome. This early identification would help to avoid family and social problems associated with the unusual symptoms of TS. In particular, school psychologists could be alerted to difficulties the TS child might experience in educational arenas, and help to provide effective remediation or compensatory strategies.

Purpose of the Study

The purpose of this study was to determine if there was a particular performance pattern of TS students on commonly used psychological and educational tests which could be used to discriminate TS from LD students.

Rationale for the Approach

A variety of research methodologies may be used in the study of TS. However, the current study relied upon a direct, individual assessment approach for a variety of reasons. The use of direct assessment with standardized instruments, provided for collection of reliable and valid data. In this approach, data collection did not rely upon subjective observations or opinions.

The use of objective and standardized tests also provided the advantage of sampling a wide variety of abilities in a short period of time. Further, such an approach also allowed for comparison of individual or group scores.

Research Question

The research question addressed in the study was whether performance on standardized psychological measures could differentiate between TS and LD students.

This study used a comprehensive battery of psychological and educational tests to isolate a pattern of abilities and deficits which characterize TS. It was believed that this pattern would be able to differentiate TS students from LD students. A comparison of TS and LD children also was made in the study.

Definition of Terms

Gilles de la Tourette's Syndrome. Tourette's Syndrome (TS) is a neurological disorder of the central nervous system, often characterized by motor and phonic tics. The disorder generally begins in childhood and is characterized by (1) motor tics that begin in the eyes, neck, or face which increase in severity and progress through other muscle groups; (2) multiple vocal tics; and (3) coprolalia, repetitive uttering of obscenities. For the purposes of this research project, children were identified by neurologists based upon Diagnostic and Statistical Manual of Mental Disorders III (American Psychiatric Association, 1980) criteria.

Learning disability. The term learning disability has been used to describe children who have difficulty learning academic material and tasks. It is generally associated with a deficit in one or more of the primary learning areas, such as reading, math, or spelling, combined with a discrepancy between intellectual ability and academic achievement. For the purposes of this research, children were identified with learning disabilities when placed in special education classes for specific learning disabilities.

Intelligence. This variable is represented by the subject's Full Scale score on the Wechsler Intelligence Scale for Children-Revised (WISC-R). Wechsler (1974) defined intelligence as the global capacity to act purposefully, think rationally, and deal effectively with the environment.

Verbal intelligence. This variable was represented by the subject's Verbal IQ score on the WISC-R, including the five subtests of Information, Similarities, Arithmetic, Vocabulary, and Comprehension. Verbal abilities measured by this scale included general range of knowledge, abstract verbal reasoning, numerical reasoning, verbal knowledge and fluency, and verbal social knowledge and judgment.

Nonverbal intelligence. This variable was represented by the subject's Performance IQ score on the WISC-R, including the five subtests of Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Coding. Nonverbal abilities measured by this scale included visual alertness to detail, nonverbal social knowledge and sequencing ability, visual analysis and synthesis of abstract designs, visual perception and assembly skills, and visual-motor dexterity and speed.

Information. This variable was represented by the subject's scaled score on the WISC-R Information subtest. General range of knowledge and information about the environment was the ability generally associated with this subtest.

Similarities. This variable was represented by the subject's scaled score on the WISC-R Similarities subtest. Abstract verbal reasoning was the ability generally associated with this subtest.

Arithmetic. This variable was represented by the subject's scaled score on the WISC-R Arithmetic subtest. Numerical reasoning ability and attention were the abilities generally associated with this subtest.

Vocabulary. This variable was represented by the subject's scaled score on the WISC-R Vocabulary subtest.

Verbal knowledge and fluency were the abilities generally associated with this subtest.

Comprehension. This variable was represented by the subject's scaled score on the WISC-R Comprehension subtest. Verbal social knowledge and judgment were the abilities generally associated with this subtest.

Picture completion. This variable was represented by the subject's scaled score on the WISC-R Picture Completion subtest. Visual alertness to the environment and essential detail were the abilities generally associated with this subtest.

Picture arrangement. This variable was represented by the subject's scaled score on the WISC-R Picture Arrangement subtest. Nonverbal social knowledge and sequencing ability were generally associated with this subtest.

Block design. This variable was represented by the subject's scaled score on the WISC-R Block Design subtest. Visual analysis and synthesis were generally associated with this subtest.

Object assembly. This variable was represented by the subject's scaled score on the WISC-R Object Assembly subtest. Visual perception and manual assembly skills were generally associated with this subtest.

Coding. This variable was represented by the subject's scaled score on the WISC-R Coding subtest. Visual-motor dexterity and speed (psychomotor speed) were generally associated with this subtest.

Reading achievement. This variable was represented by the subject's standard score on the Reading subtest of the Wide Range Achievement Test (WRAT). Reading recognition of non-contextual words was the ability generally associated with this subtest.

Arithmetic achievement. This variable was represented by the subject's standard score on the Arithmetic subtest of the Wide Range Achievement Test (WRAT). This subtest measured the ability to solve mental and written arithmetic problems.

Spelling achievement. This variable was represented by the subject's standard score on the Spelling subtest of the Wide Range Achievement Test (WRAT). This subtest measured the ability to write and spell words from dictation.

Short-term memory. This variable was represented by the subject's total score on the Visual Aural Digit Span Test (VADS). Aural and visual short-term memory were the abilities generally associated with the VADS.

Visual-motor skills. This variable was represented by the subject's Koppitz error score on the Bender Visual-Motor Gestalt Test (BVMGT). Perceptual motor skills, visual perception, motor coordination, and visual-motor integration were the abilities generally associated with the Bender (Sattler, 1982).

Receptive language. This variable was represented by the subject's standard score on the Peabody Picture Vocabulary Test-Revised (PPVT-R). Receptive vocabulary and language ability were generally associated with the PPVT-R.

Overview of the Research Report

The remainder of this dissertation includes chapters describing related literature, research methodology, results of the study, and a discussion of these results. In Chapter II, a review of related literature includes a further delineation of the problem and support for the theoretical framework, need, and approach for the study. In Chapter III, the methodology for the research project is discussed. Included in this chapter is an overview of the study and details concerning population sampling procedures, assessment techniques, data collection, and data analyses. Chapter IV presents the data and results. The report concludes with discussion of the results in Chapter V, including implications and recommendations.

CHAPTER II

REVIEW OF RELATED LITERATURE

The symptoms of Tourette's Syndrome were first described in the early 1800's. However, most of the TS research has occurred since the mid 1960's (Bruun, 1984). As this research has increased, the "successful" treatment of TS has also increased. However, the estimated prevalence of TS has also increased.

Shapiro and Shapiro (1982a) report that Itard described the first clear case of Tourette's Syndrome in 1825, but that Tourette did not address attention to the discrete symptoms of the disorder until 1885. Baker, Platt, and Fine (1983) note that

> Tourette identified the disorder as involving a degenerative nervous affliction which was manifested in a general motor incoordination, but particularly in coprolalia and echolalia. This characterization, plus his view that sufferers of the disease were destined to undergo insanity and death in its final stages, was shared by others writing about the syndrome at this time. (p.159)

Diagnostic Criteria

Although TS represents an unusual diagnostic pattern of symptoms, care must be taken to distinguish it from other tic syndromes. The uniqueness of TS is demonstrated in the variety of associated symptoms. The Diagnostic and Statistical Manual III (American Psychiatric Association, 1980) diagnostic criteria for Tourette's Syndrome include (1) an age of onset between 2 and 15 years; (2) recurrent, involuntary, repetitive, rapid, and purposeless motor movements affecting multiple muscle groups; (3) multiple vocal tics; (4) ability to voluntarily suppress symptoms over weeks or months; (5) variation in the intensity of the symptoms over weeks or months; and (6) duration of more than one year. The symptoms of involuntary muscle movements may include head-jerking, eye twitching, and facial grimaces.

Tourette pointed out that motor incoordination is the first symptom of the disease (cited in Goetz & Kiawans, 1982). "These twitches or incoordinated movements present insidiously without affecting the general health of the subject. They start most often in the face or upper extremities, and in the later case, one arm is involved before the other, although eventually both show abnormalities" (p.4). These involuntary muscle movements may spread to other muscle groups, including lower limbs and torso. Vocal tics include a variety of sounds such as grunts, barks, sniffs, or words. Coprolalia, the urge to utter obscenities, is also generally associated with the syndrome, although it occurs in only 60% of patients, and is the initial symptom in only 6% of patients (Shapiro & Shapiro, 1982b).

The symptoms of TS may be suppressed voluntarily, although suppression may require intense concentration. The tics also disappear during sleep, and are usually intensified with anxiety or environmental stress (Baker, Platt, & Fine, 1983). While the syndrome may occur at any time during childhood, Shapiro and Shapiro (1982b) report that by age 11, 96% of patients experienced the onset of the disorder. In general, the disorder is lifelong, although brief remissions may occur (DSM III, 1980).

There may also be other associated symptoms such as echokinesis (i.e., repetition of movements observed by the patient), palilalia (i.e., repetition of one's own last words), compulsive impulses to perform complicated movements, and mental coprolalia (DSM III, 1980).

Epidemiology

Jagger et al., (1982) researched the epidemiology of TS through the use of a Tourette's Syndrome Questionnaire with 75 respondents. Of those patients, 76% were male, and all but two (93%) were white. The age of onset was between 2 and 16 years, with a mean age of 7 years. The patients reported that motor tics of the eyes, face, and head appeared earliest (mean age 7.2 years), and 95% reported having these symptoms.

In support of Tourette's original observations, Jagger et al. (1982) suggest a progression of symptoms:

> Our findings suggest a cephalo-caudal sequence in the development of motor tics with the following mean ages of onset recorded: eyes, face, or head (7.2 years): shoulder or head (8.7 years); arm or hands (9.1 years); trunk (9.5 years); and legs (10.1 years). (p.269)

In addition, motor tics appeared earlier (mean age 8.7 years) than vocal tics (mean age 10.7 years) or compulsive actions (mean age 10.8 years). Only 37% of this group reported coprolalia, compared with 60% reported by Shapiro and Shapiro (1982b). Uttering low noises was the most frequent (84%) vocal tic found in the Jagger study. Compulsive actions were also reported less frequently than either motor or vocal tics. "The most frequent compulsive action was that of touching objects (55 percent of the patients). Touching of sexual organs of self or others was reported by 36% of the patients..." (Jagger et al., 1982, p.269).

Today, the diagnosis of TS appears to occur earlier in the course of TS than in previous years. However, many are assigned other diagnoses prior to the identification of TS. For example, in the Jagger et al. (1982) study, most of the TS patients had been at first misdiagnosed (e.g., transient tics of childhood and chorea). In addition, many TS children are assigned diagnoses based upon symptoms associated with other syndromes, including hyperactivity, learning disability, and minimal brain dysfunction. Ninety-seven percent of the Jagger respondents were reported to be of average or above intelligence, but the majority reported school and attentional difficulties. In addition, one-third reported that their occupational performance was moderately to severely affected by TS. "We believe that these reported school- and work-related problems are due not only to the limitations imposed by TS symptoms, e.g., noises and compulsions, but also to basic attentional difficulties, which may be exacerbated by medication side effects" (Jagger et al., 1982, p.276).

In sum, the study of TS has increased dramatically in the last 20 years. However, TS remains a significant impairment for children and adults who have the syndrome. The unusual symptoms as well as the undesirable side effects of medication present difficult obstacles for TS patients to overcome.

Theoretical Framework

Shapiro and Shapiro (1982a) have described the research and theoretical developments on TS from a historical perspective. In the early 1900s, attempts were made to classify movement disorders (Miege & Feindel, 1907), and Tourette's Syndrome was defined as "generalized tics and coprolalia, sometimes with echolalia and occasionally culminating in insanity" (Shapiro & Shapiro, 1982a, p.18). Between 1921 and 1955, psychoanalytic theories attempted to explain both tics and Tourette's Syndrome. These explanations were, for example, a neurosis resembling hysteria with organic factors (Freud, 1966), or displaced, unconscious, muscular eroticism toward the father (Sadger, 1914).

Baker, Platt, and Fine (1983) reviewed the psychoanalytic theory associated with Tourette's Syndrome and noted that TS may be seen as an extension of tics often seen in childhood. These tics may express "energy which may be otherwise expressed as overt aggressive activity, either as a conversion symptom (Abraham, 1950; Fenichel, 1945; Ferenczi, 1926) or as an obsessive-compulsive ritual (Morphew & Sim, 1969; Weisman, 1952)" (p.162). Downing, Comer and Elbert (1964) also recognize both obsessive-compulsive and hysterical elements that express the combined pressures of both hostile and sexual impulses.

Other researchers favor the etiological role of aggression over any other instinct or emotion, conceptualizing the tics (and especially coprolalia) as partial outlets for these intense feelings (Dunlap, 1960; Mesnikoff, 1959; Schneck, 1969). However, Shapiro and Shapiro (1982b) have not observed specific psychiatric syndrome of psychodynamic factor. "[c]linical reports that TS patients are characterized by excessive aggressivity, impulsivity, sexuality, self-destructiveness, obsessive-compulsiveness, enuresis, sleep disorders, anti-social behavior, or other psychopathology are not supported by our controlled study and clinical observations" (p.20).

Baker, Platt, and Fine (1983) note that some TS patients "with a high (organic) liability may develop symptoms with only normal stress, while others, with low liability, may require heavy stress before symptoms appear" (p.166). This observation may explain the conflicting results of studies examining the familial and psychological characteristics of TS patients (See Table 1).

Treatment Methods

A wide variety of treatment methodologies have been utilized in the management of TS. Therapeutic approaches have consisted of psychotherapy, behavior therapy, and organic therapies (including drug treatments). Baker, Platt, and Fine (1983) report that various treatments reach varying degrees of success, and because most reported interventions use some combination of approaches, assessment of individual treatment effectiveness is difficult. However, the use of haloperidol in the treatment of TS has resulted in relative success.

Haloperidol can reduce the TS symptoms quickly and possibly for years.

> When haloperidol works effectively at low doses, it continues to be almost miraculous. However, there are some patients who do not benefit even temporarily from haloperidol, and there are many patients among the 80% who improve initially who are unable to continue its use because of serious side effects (dysphoria and depression, Parkinsonian side effects, alterations in personality, reduced intellectual abilities,

TABLE 1
PERSONALITY AND FAMILY PATTERNS SUPPORTING A PSYCHOPATHOLOGICAL ETIOLOGY FOR TOURETTE'S SYNDROME

POSITIVE PERSONALITY

1. Ascher (1948), 1s: rigid, obedient premorbid personality.
2. Bockner (1959), 2Ss: both Ss showed obsessive traits. High incidence in literature reviewed.
3. Faux (1966), 1S: fearful, anxious.
4. Fernando (1967), 65Ss: 59% prior childhood neurosis; 30% obsessional tendencies.
5. Morphew and Sim (1969), 43Ss (37 from Fernando, 1969): high proportion of obsessive personalities, but not necessarily obsessional symptoms.
6. Mahler (1949), premorbid personality, driven, impetuous, distractible, with high degree of "motor urgency".

NEGATIVE PERSONALITY

1. Field, Corbin, Goldstein, & Klass (1966), no common psychological characteristics outstanding.
2. Lucas, Kaufman, & Morris (1967), 15Ss: no common psychopathological characteristics. No relation to schizophrenia.
3. Mahler, Luke, & Daltroff (1945), 34Ss: no relation to obsessional traits.
4. Shapiro, Shapiro, Wayne, & Clarkins (1972); Shapiro, Shapiro, & Wayne (1972), 34Ss: no relation to obsessive and compulsive neurosis or for high inhibition of hostility.

From Baker, E.L., Platt, J.A., and Fine, H.F. (1983). Tic de Gilles de la Tourette: Survey of the literature, case study, and reinterpretation. Clinical Psychology Review, 3, 157-178.

> school and social phobias, weight gain, etc." (Cohen & Leckman, 1984, p.124).

In the epidemiological study by Jagger, et al. (1982), 63% of the patients reported they were currently taking haloperidol. Of this group, 88% noted a reduction of symptoms. However, 80% of the patients who had used haloperidol reported one or more undesirable side effect, some of the main complaints being lethargy, impaired functioning, and depression. Two new drug treatments are currently being utilized, pimozide (Shapiro & Shapiro, 1984) and clonodine (Bruun, 1984).

Several researchers consider the etiology of TS to be neurophysiological in nature (Sutherland et al., 1982; Sweet, Soloman, Wayne, Shapiro, & Shapiro, 1973; Woodrow, 1974). Shapiro, Shapiro, and Clarkin (1974) suggest that the locus is probably in the right hemisphere, where neuropsychological assessment has provided evidence of central nervous system (CNS) dysfunction. However, results have not provided conclusive data. It appears that TS does represent CNS pathology, but the evidence is inconclusive to designate a particular site. Examining neuropsychological functioning in TS, Incagnoli and Kane (1982) note its "great significance in planning remedial education approaches for children with Tourette's Syndrome" (p.308).

Children with TS often have learning difficulties, and are often misdiagnosed as "simply" LD. As a consequence, associated symptoms may be treated, but the progress of TS continues. In addition to providing evidence of CNS deficits, psychological testing may be able to provide earlier detection of TS and referral to a neurologist for treatment. Educational recommendations and strategies can occur in a coordinated effort.

Psychological and Neuropsychological Test Performance

Currently, only a few studies have examined the neuropsychological test performance of TS subjects. Sutherland et al. (1982) examined the neuropsychological test results of TS, LD, and schizophrenic subjects. A total of 32 TS, 47 LD, and 55 schizophrenic subjects were examined. Included in their battery were measures assessing general intelligence, speech lateralization, memory, visual perception, spatial organization, frontal lobe functioning, and language. Results from this study demonstrated that the three groups show a unique pattern of deficits. For TS subjects, Performance IQ on the Wechsler scale was impaired and the Digit Symbol test (i.e., short-term visual memory) was low. Copying and drawing from memory the Rey Complex Figure, and delayed recall on the Wechsler Memory Figures were also impaired. Verbal fluency was low, although spontaneous talking appeared to be equal to or greater than among controls. A summary of deficits (See Table 2) reflects this pattern of right hemisphere impairment. Sutherland et al. (1982) point out that the right hemisphere is the most likely site of impairment, but a particular lobe cannot be discriminated. They state that

> Based on deficits in memory and copying of visually presented nonverbal material and reduced verbal fluency, we conclude that right temporal, orbital-frontal and to a lesser extent parietal lobe functions all show evidence of impairment....The fact that we observed abnormalities in right temporal and orbital-frontal cortical functions is quite interesting because the mesial temporal lobe and orbital-frontal cortex are intimately connected with the limbic system. This may be significant in determining the affective and profane quality of the verbal tics in TS. (p.319)

In contrast to the primarily right hemisphere impairment noted in the TS subjects, schizophrenic subjects demonstrated significant bilateral abnormalities of both frontal and temporal lobe function. LD subjects were impaired in tests of parietal lobe functions.

In another approach to the study of neuropsychological functioning in TS patients, Incagnoli and Kane (1982) used the WISC-R, Bender Gestalt, Wide Range Achievement Test, and the Halstead Neuropsychological Test Battery for Children. Thirteen children with a diagnosis of TS were assessed (mean age 11.84 years). Within the WISC-R, 4 of the 13 subjects demonstrated a significant (i.e., 15 points or greater) verbal-performance discrepancy, with no consistent trend

TABLE 2

SUMMARY OF PERFORMANCE DEFICITS ON NEUROPSYCHOLOGICAL TESTS

Hemisphere	Most Probable Site	Test	TS	LD	S
Left	P	Dig.Sp		X	
	P	R/L	X		
	P	Newc.			X
	P+T	Log.mem.	X		
	P+T	VIQ		X	
	P+T	MQ		X	
	P+T	Del.log.mem.		X	X
	T	Del.assoc.			X
	T	Semmes			
	F+T	Chicago		X	X
	F+T	WCST		X	X
Right	P	B.Des.			
	P	Pict.Comp			
	P	Vis.rep.			
	P	Mooney			
	P	Rey	X		
	P+T	PIG	X	X	X
	T	Del.Rey	X	X	X
	T	Del.Rep.	X		X
	F	Des.Flu.			X
	F	Chicago	X		X
	F	WCST			X

Abbreviations: F,frontal; P,parietal; T,temporal.
From Sutherland, R.J., Kolb, B., Schoel, W.M., Wishaw, I.Q., and Davies, D. (1982). Neuropsychological assessment of children and adults with Tourette Syndrome: A comparison with learning disabilities and schizophrenia. In A.J. Friedhoff and T.N. Chase (Eds.), Gilles de la Tourette Syndrome, New York: Raven Press.Battery for Children.

in direction. A significant deficit also was noted on the Coding subtest, with a mean scaled score of 5.92. Similarly, these subjects evidenced impairment in visual-motor tasks, with an average Bender Visual-Motor Gestalt Test score of 16.46 months below their chronological ages. On the Halstead Neuropsychological Test Battery, this group attained an average score overall. On the Wide Range Achievement Test, reading and spelling were in the expected range. However, arithmetic performance was significantly impaired, with scores approximately two years below current grade placement. Incagnoli and Kane (1982) note that this cluster of deficit scores center around visiographic abilities, and is related to a possible involvement of the basal ganglia and the regulation of motor functions, or to cortical deficits.

Bornstein, King, and Carol (1983) studied the performance of seven children (ages 9-15) with Tourette's Syndrome on a test battery including the Halstead-Reitan Neuropsychological Test Battery for Children, Peabody Picture Vocabulary Test, and WISC-R. They found "average" mental arithmetic ability but poor written arithmetic ability. Abnormal performances were noted on the Category, Trailmaking and Tactual, Performance tests of the Halstead-Reitan. These authors note a pattern of average auditory attention span but poor visual attention span.

Support for the Approach

Salvia and Ysseldyke (1981) note that assessment information can be derived from sources including current and historical observations, judgments, and tests. Current test results were chosen for the present study. Current information has the advantage of describing the child's present behavior and characteristics. Standardized tests also have advantages over observations or judgments. Tests provide a predetermined collection of questions and tasks. Salvia and Ysseldyke (1981) also point out that individual tests have the following characteristics (1) they permit tasks and questions to be presented in exactly the same way to each person tested, (2) they make many extrapersonal factors in assessment consistent for all those tested and, (3) they provide quantitative information which can be compared to the individual performance of peers.

Support for the Measurement Techniques

The measurement instruments used in the current study were selected for a variety of reasons. Primarily, these instruments provided useful and diagnostic information concerning children's ability and achievement. They also possessed sound psychometric properties and have been standardized on large, representative samples. These tests were also selected because of their widespread use by practitioners.

The instruments selected are appropriate for use with both the TS and LD groups. These instruments present auditory and visual stimuli, and require verbal or motoric responses. Although TS or LD subjects may have difficulty in particular areas of cognition or response, these instruments were selected because of their ability to isolate the difficulties which children may experience.

The Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974) is a well-standardized test, with a normative sample of 2,200 white and nonwhite American children. This standardization sample was selected to be representative of the 1970 U.S. census. The test covers an age range from 6 years-0 months to 16 years-11 months, and the standardization sample was comprised of 200 children in each of 11 age groups. The WISC-R provides three Intelligence Quotients (IQ's), (i.e., Verbal, Performance, and Full Scale) as well as scaled scores for each of the subtests. Deviation IQ's are provided, comparing each individual's score with those of the representative age group of the sample. As a result, the deviation IQ's have a mean of 100 and a standard deviation of 15, while each of the subtest scaled scores have a mean of 10 and a standard deviation of 3.

The WISC-R is an individually administered intelligence test. The WISC-R is based upon Wechsler's definition of intelligence as a global concept involving the individual's ability to act purposefully, think rationally, and deal effectively with the environment (Matarazzo, 1972; Wechsler, 1974). The test is comprised of 12 subtests, 10 of which are generally administered.

The verbal scale is comprised of the Information, Similarities, Arithmetic, Vocabulary, Comprehension, and (an optional) Digit Span subtests. The nonverbal, performance scale is comprised of the Picture Completion, Picture Arrangement, Block Design, Object Assembly, Coding, and (an optional) Mazes subtests.

On the Information subtest, the child is asked a variety of questions assessing a general range of knowledge and information about the environment. These general questions were designed to measure the type of information that is commonly acquired through experience (Sattler, 1982). The Information subtest is influenced by long-term, remote memory as well as the degree of environmental experience and alertness to the testing experience.

On the Similarities subtest, the child is asked to describe or explain how two words are alike or the same. It is necessary for the child to place both words in some type of class, either concrete or abstract. "An essential aspect of adjusting to one's environment is using these abilities to clarify, reduce, and classify the style and manner to which they respond" (Groth-Marnat, 1984, p.75). On the Similarities subtest, verbal concept formation and abstract verbal reasoning are assessed.

On the Arithmetic subtest, the child is asked to solve mathematics problems without the aid of pencil and paper. Numerical reasoning is measured as well as mental alertness, concentration and attention. According to Sattler (1982), the Arithmetic subtest "requires the use of noncognitive functions (concentration and attention) in conjunction with cognitive functions (knowledge of numerical operations). Success on the subtest is influenced by education, interests, fluctuations of attention, and transient emotional reactions" (p.174).

On the Vocabulary subtest, the child is asked to define vocabulary words which are arranged in increasing order of difficulty. This subtest "may involve a variety of cognitive functions or features - including learning ability, fund of information, richness of ideas, memory, concept formation, and language development - that may be closely related to the child's experiences and educational environment" (Sattler, 1982, p.175). This subtest displays the child's ability in verbal comprehension and expression.

On the Comprehension subtest, the child answers a number of questions regarding practical social knowledge and common sense. This subtest is influenced by cultural opportunities and experience, and to some degree by the development of moral conscience.

The performance scale is comprised of the Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Coding subtests. On the Picture Completion subtest, drawings from the everyday environment are presented, all of which lack an important element. The child is required to name the element missing from each picture. Reasoning and visual alertness to detail are required in order for the child to identify the missing essential detail. Some degree of concentration and environmental experience may affect performance.

On the Picture Arrangement subtest, the child is required to place a series of pictures in a logical sequence so that they tell a story which makes sense. The pictures are line drawings, and are presented in an incorrect order. On this subtest, the child must be able to size up the total situation, and be able to "anticipate the consequences of initial acts or situations and to interpret social situations" (Sattler, 1982, p.198).

On the Block Design subtest, the child is required to assemble designs (with blocks) identical to stimulus pictures presented. "Block Design involves the ability to perceive and analyze forms by breaking down a whole (the design) into its component parts and then assembling the component parts into the identical design, a process referred to as analysis and synthesis" (Sattler, 1982, p.183). Perceptual organization, spatial visualization, and abstract conceptualization are required because the child must utilize reasoning in spatial relationship problems.

On the Object Assembly subtest, the child must assemble four puzzles of common objects. This subtest measures visual-perceptual organization.

On the Coding subtest, the child is required to copy symbols at a rapid pace. These symbols are paired with shapes or numbers, and the child's task is to match and copy these symbols as quickly as possible. Abilities measured include speed and accuracy of visual-motor skills in a new learning situation.

Reliability coefficients for the WISC-R are excellent. Average reliability coefficients across all age ranges are .94 for the Verbal IQ, .90 for the Performance IQ, and .96 for the Full Scale IQ. Subtest reliabilities are slightly lower, but still acceptable. These range from a low of .70 for the Object Assembly subtest to a high of .86 for the Vocabulary subtest. The standard error of measurement for the Full Scale IQ is 3.19, 3.60 for the Verbal Scale IQ, and 4.66 for the Performance Scale IQ (See Table 3).

TABLE 3
AVERAGE RELIABILITY COEFFICIENTS AND STANDARD ERRORS OF MEASUREMENT FOR WECHSLER INTELLIGENCE SCALE FOR CHILDREN-REVISED SUBTESTS

Subtest and Scale	Average Reliability Coefficient	Standard Error of Measurement
Information	.85	1.19
Similarities	.81	1.34
Arithmetic	.77	1.38
Vocabulary	.86	1.15
Comprehension	.77	1.39
Digit Span	.78	1.44
Picture Completion	.77	1.45
Picture Arrangement	.73	1.57
Block Design	.85	1.17
Object Assembly	.70	1.70
Coding	.72	1.63
Mazes	.72	1.70
Verbal Scale IQ	.94	3.60
Performance IQ	.90	4.66
Full Scale IQ	.96	3.19

From Sattler, J. M. (1982). Assessment of children's intelligence and special abilities (2nd Ed.). Boston: Allyn and Bacon, 147.

Criterion validity has been established for the WISC-R through a number of studies correlating it with other intellectual measures, achievement measures, and school grades. Correlations were also established with the Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 1974). When these two tests were administered to 50, 6-year-old children, the correlations obtained were .80 for the Verbal Scale, .80 for the Performance Scale, and .82 for the Full Scale. Sattler (1982) also cites a correlational study of the WAIS and WISC-R with 40 16-year-olds. Correlations obtained in this study were .96 for the Verbal Scale, .83 for the Performance Scale, and .95 for the Full Scale.

Concurrent validity coefficients cited by Sattler (1982) range from a low of .39 to a high of .82. For example, Full Scale IQ correlations with the Stanford-Binet were .82; with the Peabody Picture Vocabulary Test, .76; and with the Peabody Individual Achievement Test, .60. In contrast, correlation with school grades was .39. Sattler concludes that "when compared to ability and achievement tests and grades, the WISC-R has satisfactory concurrent validity" (1982, p.149). In addition, Vernon (1984) notes that "studies provide strong support for the WISC-R's construct validity. Its content validity is harder to assess since Wechsler's definition of intelligence is so broad... but the diverse nature of the subtests reflects his global conception" (p.747).

The WISC-R was used in this study because it is a widely accepted instrument which measures general intellectual ability and a number of components of general ability. It also has a long history of research pertaining to a diverse range of populations, excellent reliability, and adequate validity.

The Wide Range Achievement Test (WRAT) (Jastak & Jastak, 1978) is a widely used achievement test measuring the areas of reading, spelling, and arithmetic skills. The test has two levels for administration, one to children aged 5 to 11, and one to those 12 and older. The test was standardized with 7,800 children for Level I (5-0 to 11-11 years) and 7,400 children and adults for Level II (12-0 to 64-11 years). These children and adults were selected for the standardization sample from five eastern states and two western states. The WRAT provides separate scores for each of the achievement areas in the form of standard scores having a mean of 100 and a standard deviation of 15. Grade ratings and percentile ranks are also provided in the WRAT manual. Advantages of the WRAT include its ease and speed of administration, and it is considered an acceptable alternative to group administrations of achievement tests (Reineki, 1984).

The WRAT reading subtest requires reading recognition of letters and words, and pronouncing of words. The spelling subtest requires copying symbols and spelling single words presented orally. The arithmetic subtest requires counting, solving oral problems, and performing written calculations. Scores are provided as grade equivalents, percentile ranks, and standard scores.

Reliability coefficients, as reported in the WRAT manual, are excellent. Split-half reliability coefficients range from .94 to .98 on each of the three subtests. Standard errors of measurement range from .86 to 1.70. Split-half reliabilities and standard errors of measurement for each of the subtests are presented in Table 4.

In a group of 9- to 14- year old children administered Level I and Level II simultaneously, median correlation coefficients were reported to be .91 for the Reading subtest, .90 for the Spelling subtest, and .86 for the Arithmetic subtest (Jastak & Jastak, 1978).

The WRAT appears to have adequate concurrent validity. Sattler (1982) reports an average correlation of .60 between the WRAT and other achievement tests, such as the Stanford Achievement Test, Metropolitan Achievement Test, and the Peabody Individual Achievement Test. The WRAT manual reports a concurrent validity study between the WRAT and the WISC. The correlations between the WISC Full Scale IQ and

TABLE 4
SUMMARY OF RELIABILITY COEFFICIENTS AND STANDARD ERRORS OF MEASUREMENT FOR THE WIDE RANGE ACHIEVEMENT TEST

Level I (7 groups, N=200 each)

Test	ages	r	SEM
Reading	5-11	>.98	1.05-1.39
Spelling	5-11	>.96	.86-1.20
Arithmetic	5-11	>.94	.88-1.42

Level II (7 groups, N-200 each)

Test	ages	r	SEM
Reading	12-24	>.98	1.33-1.70
Spelling	12-24	>.97	1.13-1.34
Arithmetic	12-24	>.94	1.21-1.38

From Jastak, J.F. and Jastak, S. (1978). The Wide Range Achievement Test (rev.ed.). Wilmington, DE: Jastak Associates, 46.

the three achievement areas ranged from .75 to .85 (Jastak & Jastak, 1978). Sattler (1982) also reports that median correlations between the WRAT subtest scores and the WISC and WISC-R are .60 with the Verbal and Full Scale IQ's, and .40 with the Performance IQ.

The Bender Visual-Motor Gestalt Test (BVMGT) (Bender, 1938) is a measure of visual-motor integration, developed for children ages 5-10. Koppitz (1964, 1975) has conducted a standardization of the BVMGT, resulting in percentile norms for children aged 5-0 to 11-11 years. The test was originally developed as a visual-motor test with adult clinical populations and as a developmental test for young children (Sattler, 1982).

The BVMGT is individually administered, and requires the child to draw nine geometric designs, one at a time, on a blank sheet of paper. Administration involves the presentation of nine stimulus cards (i.e., designs) which the child is asked to copy in sequence with the stimulus as a model. The test procedures and scoring method utilized in the current study were derived from the Koppitz system (Koppitz, 1964, 1975). The Koppitz Developmental Bender Scoring System yields a developmental age score, based upon the number of errors in the visual-motor reproduction of the designs. These errors consist of distortions of shape, rotations, problems of integration, and perseveration.

The Koppitz standardization of the BVMGT was conducted on 1,104 kindergarten to fourth-grade children in eastern and midwestern public schools. Interscorer reliability is acceptable, varying between .88 and .96. However, retest reliability over a 4-month interval ranged from .55 to .66. A group of nine test-retest reliability studies reported by Koppitz (1975) provided coefficients ranging from .50 to .90, with a mean of .71. Koppitz also reports adequate concurrent and predictive validity coefficients (e.g., with school readiness and achievement).

A number of authors question the validity of the BVMGT as a measure or predictor of achievement. For example, Buckley (1978) reviewed 25 studies, conducted between 1966 and 1977, correlating the BVMGT with reading and achievement. His review found no significant correlations in half of the studies examined. However, Koppitz and others (e.g., Schneider & Spivack, 1979) hold that the BVMGT is a valid predictor of general school performance. Koppitz (1975) notes the BVMGT appears "to be most successful in predicting overall school functioning and the rate of progress in total achievement....LD pupils and slow learners mature at a significantly slower rate in visual-motor integration, as measured on the Bender Test, than do well-functioning children" (p.70). In addition, Whitworth (1984) notes that the Bender is quite appropriate as a "rapid, efficient measure of perceptual motor and cognitive development in young children" (p. 96).

The Peabody Picture Vocabulary Test - Revised (PPVT-R) (Dunn & Dunn, 1981) is a widely used measure of receptive (hearing) vocabulary for ages 2-6 years of age to adult. "One of the most significant features of the PPVT-R is its flexibility and applicability to a number of educational populations" (Umberger, 1984, p. 495). The PPVT-R is a multiple-choice test consisting of 175 plates, each with four separate line drawings of objects or activities. The child is presented a stimulus word and asked to point to the picture which represents this stimulus word. Raw scores are converted into standard scores, with a mean of 100 and a standard deviation of 15. These standard scores have a range from 40 to 160.

The 1981 standardization of the PPVT-R was conducted on a representative sample of 4,200 children ages 2-6 years through 40-0 years. The sample was selected on the basis of 1970 U.S. census data. Groups of 200 children, equally divided by sex, were selected at each half-year interval for children ages 2-6 years to 6-11 years. Equal groups were selected at 1-year intervals for ages 7 through 18 years.

Reliability coefficients are reported in the PPVT-R manual (Dunn & Dunn, 1981). Split-half reliability coefficients for ages 2-6 years through 18-6 years range from .67 to .88, with a median of .80. Alternate form reliabilities ranged from .74 to .89, with a median of .81 for each of the age ranges in the childrens' sample.

Validity information is also contained in the PPVT-R manual (Dunn & Dunn, 1981). However, criterion validity is based upon studies of the PPVT (i.e., before revision). In support of the revised edition, a median correlation of .70 is reported between the PPVT-R and the PPVT. The manual reports a number of criterion validity studies, correlating the PPVT with vocabulary and individual intelligence tests. Selected comparisons are presented in Table 5.

The Visual Aural Digit Span Test (VADS) (Koppitz, 1977) is a measure of short-term memory of auditory and visual stimuli. It was developed for children between five years six months and twelve years of age. The VADS can be administered in approximately ten minutes. Four subtests are administered, varying the stimuli (auditory or visual) and expression (oral or written). The VADS was standardized on 810 public school children from five states (New York, Ohio, California, Virginia, and Texas). The standardization sample was comprised of 81% white, 13% black, 6% Hispanic, and 1% Oriental children.

On the VADS, the child is required to repeat numbers presented both visually and orally. The VADS consists of

TABLE 5
CORRELATIONS BETWEEN THE PEABODY PICTURE VOCABULARY TEST AND WITH VOCABULARY AND INDIVIDUAL INTELLIGENCE TESTS

Criterion Measure	Number of Correlations	Range of Correlations	Median
Stanford-Binet Vocabulary Subtest	2	.68-.76	.72
WISC Vocabulary Subtest	10	.37-.83	.69
WAIS Vocabulary Subtest	2	.60-.67	.64
WPPSI Vocabulary Subtest	2	.20-.40	.30
Stanford-Binet Intelligence Scale	72	.15-.88	.62
WISC Verbal Scale	65	.04-.88	.66
WISC Full Scale	66	.16-.91	.64
WAIS Verbal Scale	7	.21-.91	.71
WAIS Full Scale	8	.17-.92	.72

From Dunn, L.M., and Dunn, L.M. (1981). Peabody Picture Vocabulary Test - Revised. Circle Pines, MN: American Guidance Service, p. 62.

four subtests: (1) Aural-Oral - stimulus numbers are presented aurally, and the child is required to repeat them orally from memory; (2) Visual-Oral - stimulus numbers are presented visually, and the child is required to repeat them orally from memory; (3) Aural-Written - stimulus numbers are presented aurally, and the child is required to write them from memory; and (4) Visual-Written - stimulus numbers are presented visually, and the child is required to write them from memory.

Scores for the VADS are derived from each of the four subtests individually and from combined scores. Combination scores include (a) the two aural subtest scores, (b) the two visual subtest scores, (c) the two oral subtest scores, (d) the two written subtest scores, (e) like modality scores (Aural-Oral and Visual-Written) to form an Intrasensory Integration score, (f) unlike modality scores (Aural-Written and Visual-Oral) to form an Intersensory Integration score, and (g) a Total score, based upon all four subtests.

Test-retest reliabilities are reported in the VADS manual (Koppitz, 1977) for children with learning or behavioral problems. These reliabilities range from .72 to .92, after an average interval of 6 1/2 weeks. The Total score had the highest test-retest reliability, with correlations for the four subtest scores and the Total score ranging between .65 and .79. Individual scale and Total score correlations are reported in Table 6.

Validity coefficients between the VADS and the Wide Range Achievement Test are reported in the manual. For two samples at 8 years of age and two at 10 years of age, validity coefficients range from .29 to .65. Median coefficients are reported to be .60 for the Reading subtest, .62 for the Spelling subtest, and .56 for the Arithmetic subtest. The VADS was also shown to be correlated well with the Verbal and Full Scales scores of the WISC, but not well with the Performance Scale (Verbal IQ r = .45; Full Scale IQ r = .39; Performance IQ r = .26). A high correlation was also noted between the VADS and the Digit Span subtest (r = .68). These correlation coefficients are presented in Table 7.

Summary

In summary, TS represents a complex disorder involving purposeless motor movements and vocal tics. The study of TS is difficult because of the variations in the intensity of primary and associated symptoms. Because of these associated symptoms, TS children are often misdiagnosed, based upon symptoms of hyperactivity, learning disability, and minimal brain dysfunction. The current study attempted to determine the psychological test performance of TS children, and to differentiate these children from LD

TABLE 6
TEST-RETEST RELIABILITY COEFFICIENTS FOR THE VISUAL AURAL DIGIT SPAN TEST

VADS SUBTEST	CA 6 TO 10 (N=35)	CA 11 AND 12 (N=27)
Aural-Oral	.84	.85
Visual-Oral	.74	.84
Aural-Written	.78	.72
Visual-Written	.77	.80
Aural Input	.85	.87
Visual Input	.90	.88
Oral Expression	.84	.79
Written Expression	.82	.80
Intrasensory Integration	.87	.87
Intersensory Integration	.85	.86
Total VADS	.92	.90

From Koppitz, E.M. (1977). *The Visual Aural Digit Span Test*. New York: Grune & Stratton, p. 58.

TABLE 7
CORRELATIONS BETWEEN THE VISUAL AURAL DIGIT SPAN TEST AND WECHSLER INTELLIGENCE SCALE FOR CHILDREN-REVISED

VADS	Verbal IQ	Performance IQ	Full Scale IQ	Digit Span
A-O	.34	.12	.26	.61
V-O	.43	.23	.36	.57
A-W	.32	.24	.31	.63
V-W	.46	.31	.42	.58
AI	.36	.20	.31	.69
VI	.47	.28	.41	.61
OE	.43	.20	.35	.65
WE	.43	.30	.49	.65
Intra	.46	.26	.39	.67
Inter	.41	.25	.36	.65
Total	.45	.26	.39	.68

From Koppitz, E.M. (1977). *The Visual Aural Digit Span Test*. New York: Grune & Stratton, p. 115.

children with a diagnosis of TS. If this is determined, earlier detection of TS at the school level can occur, and appropriate referral and educational remediations can occur.

CHAPTER III

METHODOLOGY

The purpose of this study was to investigate whether the pattern of psychological test performance of TS subjects could be used to discriminate them from LD subjects. Tourette's Syndrome represents an unusual disorder, believed to be of CNS origin. Knowledge of the psychological test performance of TS students is useful in the early identification and treatment of the disorder. In addition, knowledge of this pattern assists school psychologists or mental health practitioners in differentiating TS students from LD students.

In order to determine if a clear pattern of abilities and deficits existed, results of a comprehensive psychological test battery were used. This battery included tests of general intellectual ability, memory, visual-motor skills, language, and academic achievement. Two independent groups of students were compared; a TS group and a LD group. The TS students were selected from members of the Jacksonville, Florida Tourettes' support group, on the basis of availability and agreement to participate in the study. The LD students were selected on the basis of matched ability and selection from learning disabled students in the Jacksonville, Florida public school population. Data collection occurred during 1986.

The hypotheses, population and sample, instruments, research and data analysis procedures, and limitations of the study are discussed in this chapter.

Delineation of Variables

The variables examined in this study and the data source for each were as follows:

Variable	Source
Verbal IQ	WISC-R
Performance IQ	WISC-R
Full Scale IQ	WISC-R
Information Subtest	WISC-R
Similarities Subtest	WISC-R
Arithmetic Subtest	WISC-R
Vocabulary Subtest	WISC-R
Comprehension	WISC-R
Picture Completion Subtest	WISC-R
Picture Arrangement Subtest	WISC-R
Block Design Subtest	WISC-R
Object Assembly Subtest	WISC-R
Coding Subtest	WISC-R
Visual-Motor Skills	BVMGT
Short-Term Memory	VADS
Aural Input	VADS
Visual Input	VADS
Oral Expression	VADS
Written Expression	VADS
Aural-Oral Processing	VADS
Visual-Oral Processing	VADS
Aural-Written Processing	VADS
Visual-Written Processing	VADS
Intrasensory Integration	VADS
Intersensory Integration	VADS
Receptive Language	PPVT-R
Reading Recognition	WRAT
Spelling	WRAT
Arithmetic	WRAT

Hypotheses

As stated previously, this study investigated the psychological test performance of TS students and compared their test performance with that of LD students. The research question was whether TS students could be differentiated from LD students on the basis of standardized psychological measures. Each group was compared on each of the variables in order to determine whether a significant difference was present (i.e., at or greater than the .05 level of significance). If the *t*-value was at or greater than the .05 level of significance, the null hypotheses was rejected. The following null hypotheses were tested:

Ho1 - There are no differences between the TS group and the LD group in their performance on the Information subtest of the WISC-R.

Ho2 - There are no differences between the TS group and the LD group in their performance on the Similarities subtest of the WISC-R.

Ho3 - There are no differences between the TS group and the LD group in their performance on the Arithmetic subtest of the WISC-R.

Ho4 - There are no differences between the TS group and the LD group in their performance on the Vocabulary subtest of the WISC-R.

Ho5 - There are no differences between the TS group and the LD group in their performance on the Comprehension subtest of the WISC-R.

Ho6 - There are no differences between the TS group and the LD group in their performance on the Picture Completion subtest of the WISC-R.

Ho7 - There are no differences between the TS group and the LD group in their performance on the Picture Arrangement subtest of the WISC-R.

Ho8 - There are no differences between the TS group and the LD group in their performance on the Block Design subtest of the WISC-R.

Ho9 - There are no differences between the TS group and the LD group in their performance on the Object Assembly subtest of the WISC-R.

Ho10 - There are no differences between the TS group and the LD group in their performance on the Coding subtest of the WISC-R.

Ho11 - There are no differences between the TS group and the LD group in their Verbal IQ on the WISC-R.

Ho12 - There are no differences between the TS group and the LD group in their Performance IQ on the WISC-R.

Ho13 - There are no differences between the TS group and the LD group in their Full Scale IQ on the WISC-R.

Ho14 - There are no differences between the TS group and the LD group in their performance on the Aural-Oral subtest of the VADS.

Ho15 - There are no differences between the TS group and the LD group in their performance on the Visual-Oral subtest of the VADS.

Ho16 - There are no differences between the TS group and the LD group in their performance on the Aural-Written subtest of the VADS.

Ho17 - There are no differences between the TS group and the LD group in their performance on the Visual-Written subtest of the VADS.

Ho18 - There are no differences between the TS group and the LD group in their performance on the Aural Input subtest of the VADS.

Ho19 - There are no differences between the TS group and the LD group in their performance on the Visual Input subtest of the VADS.

Ho20 - There are no differences between the TS group and the LD group in their performance on the Oral Expression subtest of the VADS.

Ho21 - There are no differences between the TS group and the LD group in their performance on the Written Expression subtest of the VADS.

Ho22 - There are no differences between the TS group and the LD group in their performance on the Intrasensory Integration subtest of the VADS.

Ho23 - There are no differences between the TS group and the LD group in their performance on the Intersensory Integration subtest of the VADS.

Ho24 - There are no differences between the TS group and the LD group in their performance on the Total VADS.

Ho25 - There are no differences between the TS group and the LD group in their performance on the PPVT-R.

Ho26 - There are no differences between the TS group and the LD group in their performance on the BVMGT.

Ho27 - There are no differences between the TS group and the LD group in their performance on the reading portion of the WRAT.

Ho28 - There are no differences between the TS group and the LD group in their performance on the spelling portion of the WRAT.

Ho29 - There are no differences between the TS group and the LD group in their performance on the arithmetic portion of the WRAT.

Population

The samples for the current study were derived from the general student population of Jacksonville, a large metropolitan community in northeast Florida. Selection of subjects began with the TS group because of the relatively small incidence of the disorder in the population. The TS subjects were those students referred to the study by the local, Jacksonville Tourette's support group. Twenty-five TS subjects were selected on this basis.

Twenty-five LD students were selected on the basis of matched ability level and age with subjects in the TS group. These LD students were selected from a population enrolled in special education classes in the Duval County (i.e., Jacksonville) Public Schools. For this group, placement in LD classes was based upon criteria established by the State of Florida Department of Education and the Duval County Public Schools. The process and criteria for placement in an LD class are as follows. Students experiencing academic difficulties within the regular classroom are referred for evaluation to determine whether they meet the established criteria for placement in classes for specific learning disabilities. These criteria require a learning process deficit, coupled with a discrepancy of one standard deviation between ability and achievement levels. These criteria are defined by the Duval County School Board (1986) as follows:

1. The student must have an ability level which falls above minus two standard deviations of the mean, as determined by an approved measure of intelligence. This is generally based upon scores from the Wechsler Intelligence Scale for Children-Revised, or the Stanford-Binet Intelligence Scale.
2. A process deficit must exist in one of the primary learning areas, such as memory, language, visual-motor skills, or written language. This process deficit must be reflected in standard scores falling below minus one standard deviation below the measured intellectual ability level.
3. The student must have an achievement discrepancy score at least one standard deviation below the measured intellectual ability level. These achievement scores are based upon individually administered achievement tests (typically in reading recognition, reading comprehension, spelling, or arithmetic).
4. The learning difficulties the student experiences can not be due to physical impairments, mental retardation, or vision or hearing disabilities.

The LD subjects selected were paired on the basis of comparable intellectual ability with subjects in the TS group. For this study, 25 names were randomly selected from files of students enrolled in specific learning disability classes. Matched intellectual ability and age were the criteria used for selection.

For the LD group, matched intellectual ability was defined as plus or minus two standard errors of measurement (SEM) from the respective TS subject. The measure of intellectual ability was each subject's Full Scale score on the Wechsler Intelligence Scale for Children-Revised. In addition, LD subjects were matched with TS subjects in respect to chronological age. The LD subjects were selected on the basis of age being plus or minus six months from the respective TS subject at the time of each subject's intellectual evaluation. In the matching procedure, the LD students were not matched on the basis of gender.

Sampling Procedure

The TS group was selected by referral from a local Tourette's support group in Duval County, Florida. This group was identified by their meeting DSM III (1980) criteria for TS, described earlier in Chapter II. Introductory phone calls were made and letters sent to parents, including a brief description of the study, qualifications of the researcher, and a parental consent form (Appendix A) for participation in the study. Following receipt of parent permission, demographic information was recorded, and an identification number was assigned to each student.

LD students were identified after the selection of the TS subjects. Class lists of all students in learning disabilities classes in Duval County were obtained. From these lists, groups of LD students were derived, matched with a target TS subject by age and ability level (i.e., IQ). Introductory letters, a brief description of the study, and a parent consent form were sent to parents. Following receipt of parent permission, data collection began. If parent permission was not obtained, a phone call was made to parents requesting their participation. If consent was not given, replacement for the subject was made through the random selection process described above. A more detailed description of the characteristics of the two groups is presented in Chapter IV.

Assessment Techniques

Within the current study, a wide variety of psychological tests were used in order to establish a view of overall functioning for both groups. Included were tests of intellectual ability, visual-motor skills, short-term memory, academic skills, and receptive language. These instruments were selected because of their wide acceptance and diagnostic utility.

The Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974) was used as a measure of general intelligence. The WISC-R yields three primary scores: a Verbal IQ, a Performance IQ, and a Full Scale IQ. These IQ's are in the form of derived scores, with a mean of 100 and a standard deviation of 15. In addition, 10 subtest scores, each having a mean of 10 and a standard deviation of 3, were obtained.

The Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981) was used as a measure of receptive language. The total score for the PPVT-R is in the form of a derived score with a mean of 100 and a standard deviation of 15.

The Bender Visual-Motor Gestalt Test (Bender, 1938) was used as a measure of visual-motor skills. The Bender is scored for errors of reproduction, and a corresponding age score is derived. In the Koppitz (1975) standardization, these age scores are in the form of age ranges. For the statistical analysis of these age ranges, the mean age in months was used (see Appendix B). The child's age equivalent on the BVMGT was subtracted from the corresponding chronological age. The difference score, in months was used in the analysis of performance on this test.

The Visual-Aural Digit Span Test (Koppitz, 1977) was used as the measure of auditory short-term memory. The VADS is scored by counting the number of digits a child can remember within each of the subtests. For example, when presented auditory stimuli, the child can orally repeat up to seven numbers at one time. The total raw score is the sum of the four subtests (i.e., Aural-Oral, Visual-Oral, Aural-Written, and Visual-Written processing). The VADS manual provides an age score for the total raw score. These age scores are in the form of age ranges and percentile scores. The total raw score and subtest raw scores were converted to the percentile scores provided in the VADS manual.

The Wide Range Achievement Test (Jastak, 1978) was used as the measure of academic achievement in the areas of spelling, math, and reading. Scores on the WRAT are in the form of derived scores with a mean of 100 and a standard deviation of 15.

The administration of the tests followed the procedures set forth in each of the respective administration manuals. The order of test administrations was as follows:

1. Bender Visual-Motor Gestalt Test
2. Wechsler Intelligence Scale for Children-Revised
   *Break of 10 to 15 minutes to help avoid fatigue
3. Visual Aural Digit Span Test
4. Peabody Picture Vocabulary Test-Revised
5. Wide Range Achievement Test

Research Procedures

A sample of 25 TS subjects was obtained from a local Tourette's support group. Additional criteria for the selection of the TS subjects included attendance in elementary or secondary schools and agreement to participate in the study. If a psychological evaluation was available for a student, it was reviewed. Suitability of prior test data was based upon (1) the nature of the evaluation and the instruments used, (2) evaluation within one year of the date of review, and (3) administration of the evaluation by a State of Florida licensed or certified psychologist or school psychologist. For example, if the WISC-R had been administered within one year by a certified school psychologist, the data were accepted for the study.

A matched sample of LD students was then assembled. These students were matched to the TS group on the basis of age (with three months) and intellectual ability (within two standard errors of measurement). This matched sample of LD students was selected randomly by a review of files of students placed in specific learning disabilities classes in Duval County Public Schools.

Description of Data Analysis

The analyses of the data from this study were primarily comparisons of average scores for each group. As a result, independent sample *t*-tests were used to determine significances of differences between each group's performance on each of the variables. The level of significance was set at the .05 level. The *t*-test procedure was used to determine whether the differences between each group's scores was large enough to assume that the corresponding population means were different. The independent *t*-test procedure was used because it assumes that the test scores obtained from the TS and LD groups are not related to each other.

The means and standard deviations were also computed for each group, and patterns of abilities and deficits were compared.

Methodological Limitations

Limitations due to the methods used in this study included variables which could not be controlled for, including environmental conditions, and the variations of each student due to fatigue or concentration. These students were tested in a variety of settings, usually a public or private school. However, the conditions when testing occurred were variable, with some almost ideal and others less than perfect. As a consequence, all environmental variables could not be controlled. However, the environmental conditions which were present were typical of conditions encountered in the general practices of school psychologists.

The method used also did not control for variables within the student which could have effected the results obtained. For example, fatigue may have affected student performance, and the school psychologist may not have been aware of this factor. Attention and concentration also may have been variable, not directly attributable to the conditions being studied (i.e., TS or LD) but rather to chance factors. These variables were not controlled, but are considered to be random factors which effect the daily practice of school psychologists, and are typical of test performance and results.

CHAPTER IV

RESULTS

The purpose of this study was to examine the pattern of psychological test performance of TS subjects, and to compare their performance to that of LD students. The hypotheses presented in Chapter III were tested using the independent sample t-test procedure. The data analyses were done using a statistical package developed by Bolding (1984).

A total of 50 children participated in this study, with half in the TS group (n=25) and half in the LD group (n=25). The subjects were tested on the Wechsler Intelligence Scale for Children-Revised, Bender Visual-Motor Gestalt Test, Visual Aural Digit Span Test, Peabody Picture Vocabulary Test-Revised, the Wide Range Achievement Test. The groups were compared on each of the variables outlined in Chapter III. The criterion for statistical significance was set at the .05 level for all analyses.

The TS and LD samples are described in this chapter. The t-test results from comparison of the means of the TS and the LD students are also presented.

Demographic Data

Table 8 presents the demographic data for the TS and LD groups. The TS group consisted solely of white students (n=25), while the LD group consisted of 21 white students

TABLE 8
DEMOGRAPHIC DATA FOR THE TOURETTE'S SYNDROME
AND LEARNING DISABLED GROUPS OF STUDENTS

	TS	LD
Race		
White	25	21
Non-white	0	4
Sex		
Male	24	22
Female	1	3
Age		
Mean	127.64 months	127.28 months
SD	25.82 months	25.20 months
Full Scale IQ		
Mean	108.00	107.08
SD	13.02	12.95

and 4 non-white students. In addition, 24 male and female subjects made up the TS group, while the LD group contained 22 male and 3 female subjects. As described in Chapter III, age and ability level were matched as a condition of the study. Consequently, the mean age of the TS group was 127.64 months (10-7 years), while the mean age of the LD group was 127.28 months (10-7 years). The mean Full Scale IQs were also approximately equal, with the TS group at 108.00, and the LD group at 107.08.

Evaluations of the Null Hypotheses

The research question was whether TS and LD students could be differentiated on the basis of psychological tests. Thus, the first step in the data analysis was to complete a series of *t*-tests to determine significances of differences between scores of students in the TS group and the scores of students in the LD group. Tables 9 through 13 present the means, standard deviations, *t*-values, degrees of freedom, and probability levels for analyses of each of the scales of the instruments used.

The means, standard deviations, and *t*-test results for the WISC-R subscales are shown in Table 9. The TS group had higher means on 7 of the 10 subscales, as well as on the Verbal, Performance, and Full Scale IQ scales. However, *t*-tests revealed statistically significant differences for only 4 of these 13 scales. The TS group had a statistically

TABLE 9
WECHSLER INTELLIGENCE SCALE FOR CHILDREN - REVISED MEANS, STANDARD DEVIATIONS, AND *t*-VALUES FOR THE TOURETTE'S SYNDROME AND LEARNING DISABLED GROUPS

Scale	Mean	sd	*t*	df	Probability
WISC-R Scales					
Information					
TS Group	11.16	2.44			
LD Group	9.80	2.66	1.88	48	0.03*
Similarities					
TS Group	11.92	2.58			
LD Group	12.04	3.30	0.14	48	0.44
Arithmetic					
TS Group	9.92	2.63			
LD Group	10.04	2.78	0.16	48	0.44
Vocabulary					
TS Group	11.84	2.75			
LD Group	10.48	2.47	1.84	48	0.03*
Comprehension					
TS Group	11.16	2.27			
LD Group	10.88	2.74	0.39	48	0.35
Picture Completion					
TS Group	10.72	2.28			
LD Group	11.68	2.08	1.56	48	0.06
Picture Arrangement					
TS Group	11.24	2.24			
LD Group	11.92	2.84	0.94	48	0.18

TABLE 9 - continued

Scale	Mean	sd	t	df	Probability
Block Design					
TS Group	12.32	3.50			
LD Group	10.48	2.87	2.03	48	0.02*
Object Assembly					
TS Group	11.88	2.40			
LD Group	11.32	2.87	0.75	48	0.23
Coding					
TS Group	9.28	3.29			
LD Group	11.08	2.48	2.19	48	0.02*
WISC-R Verbal IQ					
TS Group	106.96	12.38			
LD Group	103.68	14.27	0.87	48	0.20
WISC-R Performance IQ					
TS Group	107.40	13.79			
LD Group	105.60	23.82	0.33	48	0.37
WISC-R Full Scale IQ					
TS Group	108.00	13.02			
LD Group	107.08	12.95	0.25	48	0.40

*Significant at the .05 level.

significantly higher mean score on the Information, Vocabulary, and Block Design subscales and a statistically significantly lower mean score on the Coding subscale. Hypotheses 1 through 13 relate to WISC-R performance. Therefore, on the basis of data in Table 9, null hypotheses 1, 4, 8, and 10 were rejected while the other null hypotheses in this set were not rejected.

The means, standard deviations, and t-test results for the VADS subscales are shown in Table 10. The TS group had higher means on 4 of the 10 scales. However, t-tests did not reveal statistically significant mean scores on any of the subtest scores or the total VADS score. Hypotheses 14 through 24 relate to VADS performance. Therefore, on the basis of the data in Table 10, null hypotheses 14 through 24 were not rejected.

The means, standard deviations, and t-test results for the BVMGT are shown in Table 11. Both the TS and LD groups had mean age scores below their respective age expectancies. However, the t-test did not reveal a statistical significance between the mean scores. Hypothesis 25 relates to BVMGT performance. Therefore, on the basis of the data in Table 11, null hypothesis twenty-five was not rejected.

The means, standard deviations, and t-test results for the PPVT-R are shown in Table 12. The TS group had a higher mean score on the PPVT-R, and the t-test revealed a

TABLE 10
VISUAL AURAL DIGIT SPAN TEST
MEANS, STANDARD DEVIATIONS, AND *t*-VALUES FOR THE TOURETTE'S SYNDROME AND LEARNING DISABLED GROUPS

Scale	Mean	sd	*t*	df	Probability
Aural-Oral Processing					
TS Group	42.40	24.20			
LD Group	48.80	34.20	0.76	48	0.23
Visual-Oral Processing					
TS Group	53.20	30.51			
LD Group	48.00	33.73	0.57	48	0.29
Aural-Written Processing					
TS Group	45.20	22.75			
LD Group	43.60	33.50	0.20	48	0.42
Visual-Written Processing					
TS Group	50.40	35.70			
LD Group	42.60	35.68	0.77	48	0.23
Aural Input					
TS Group	39.30	21.45			
LD Group	45.90	36.88	0.77	48	0.11
Visual Input					
TS Group	42.80	30.63			
LD Group	40.10	32.72	0.30	48	0.38
Oral Expression					
TS Group	38.40	20.28			
LD Group	43.50	36.16	0.62	48	0.27

TABLE 10 - continued

Scale	Mean	sd	*t*	df	Probability
Written Expression					
TS Group	38.70	23.14			
LD Group	42.30	34.48	0.43	48	0.34
Intrasensory Integration					
TS Group	36.80	21.63			
LD Group	42.20	36.52	0.64	48	0.27
Intersensory Integration					
TS Group	42.40	23.19			
LD Group	43.00	34.40	0.36	48	0.36
Total Vads					
TS Group	38.56	21.01			
LD Group	42.50	36.24	0.47	48	0.32

TABLE 11
BENDER VISUAL-MOTOR GESTALT
MEANS, STANDARD DEVIATIONS, AND *t*-VALUE FOR THE TOURETTE'S SYNDROME AND LEARNING DISABLED GROUPS

Scale	Mean	sd	*t*	df	Probability
Age Difference Score (in months)					
TS Group	-9.80	17.95			
LD Group	-13.64	18.66	0.74	48	0.23

TABLE 12
PEABODY PICTURE VOCABULARY TEST - REVISED
MEANS, STANDARD DEVIATIONS, AND t-VALUE FOR
THE TOURETTE'S SYNDROME AND LEARNING DISABLED GROUPS

Scale	Mean	sd	t	df	Probability
Standard Score					
TS Group	105.24	12.93			
LD Group	97.16	14.66	2.07	48	0.02*

*Significant at the .05 level.

statistically significant difference on this scale. Hypothesis 26 relates to PPVT-R performance. Therefore, on the basis of data in Table 12, null hypothesis 26 was rejected.

The means, standard deviations, and *t*-test results for the WRAT are shown in Table 13. The TS group had higher means on all three of the WRAT scales. However, *t*-tests revealed statistically significant differences on only two of these three scales. The TS group had a statistically significant higher mean score on the Reading and Spelling subscales. Hypotheses 27 through 29 relate to WRAT performance. Therefore, on the basis of data in Table 13, null hypotheses 27 and 28 were rejected, while null hypothesis 29 was not rejected.

Tourette's Syndrome Group Performance

When compared to average performance on the measures utilized, some interesting patterns in the performance of the TS group emerged. The TS group had a WISC-R Full Scale mean score of 108.00, which is slightly more than one half of one standard deviation above the mean score for the scale. Also, there was no significant difference in the group's average Verbal and Performance IQ scores. In addition, as would be expected by the Full Scale score, many of the individual subtest scores on the WISC-R fell above their respective means. These were the subtests of

TABLE 13
WIDE RANGE ACHIEVEMENT TEST
MEANS, STANDARD DEVIATIONS, AND *t*-VALUES FOR THE TOURETTE'S SYNDROME AND LEARNING DISABLED GROUPS

Scale	Mean	sd	*t*	df	Probability
Reading					
TS Group	104.88	9.12			
LD Group	95.48	13.52	2.88	48	0.01**
Spelling					
TS Group	105.68	9.02			
LD Group	92.20	14.95	3.86	48	0.01**
Arithmetic					
TS Group	97.04	8.59			
LD Group	95.76	13.71	0.40	48	0.35

*Significant at the .01 level.

Information, Similarities, Vocabulary, Comprehension, Picture Completion, Picture Arrangement, Block Design, and Object Assembly. The Arithmetic and Coding subtest means fell below their respective subtest means.

Although the TS group's WISC-R IQ fell above the test mean, almost all their VADS percentiles were below the mean (i.e., 50%ile). Only the Visual-Oral and the Visual-Written subscale means fell at the test mean. The Total VADS score for the TS group fell at the 38.56%ile. In addition, Aural Input, Oral Expression, Written Expression, Intrasensory Integration, and Intersensory Integration all fell at or below the 40%ile.

On the PPVT-R, the TS group scored slightly above the Full Scale IQ mean, with the TS group mean PPVT-R score being 105.24.

On the WRAT, the TS group scored above the test mean on the Reading and Spelling subscales of the test. However, the TS group performance was below the test mean on the Arithmetic subscale. Notably, the TS group mean on the WRAT Arithmetic subtest score was 10.96 standard score points below the corresponding TS Full Scale IQ score on the WISC-R.

On the BVMGT, the TS group was 9.8 months below their expected age scores.

Learning Disabled Group Performance

On the WISC-R, the LD group had a mean score (107.08) which was above the test mean of 100. This was expected because ability level was a condition for selection of the matched pairs. Verbal abilities (VIQ = 102.68) and performance abilities (PIQ = 105.60) were also relatively equal for this group. Individual subtest scores for this group were above their respective subtest averages on the scales of Similarities, Vocabulary, Comprehension, Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Coding. Only the Information scale fell below the subtest mean.

As with the TS group, the LD group scored below the subtest mean on the VADS; all percentile scores fell below the subtest means. Notably, all of the LD group's percentile scores on the VADS fell between the 40%ile and 50%ile, with their Total VADS score at the 42.50%ile.

On the PPVT-R, the LD group scored below the test mean. Their score is 9.92 standard score points below their mean Full Scale IQ, and 6.52 standard score points below their mean Verbal IQ.

The LD group scored below the test mean for the WRAT and considerably below their mean Full Scale IQ. On the Reading subtest, the LD group mean score was 95.48, which is 11.60 standard score points below the LD group's mean Full

Scale IQ. On the Spelling portion of the WRAT, the mean score was 92.20, which is 15.06 standard score points below the LD group's mean Full Scale IQ. On the Arithmetic portion of the WRAT, the mean score was 95.76, which is 11.32 standard score points below the LD group's mean Full Scale IQ.

On the BVMGT, the LD group was below the test average, with a mean 13.64 months below their chronological age expectations.

CHAPTER V
DISCUSSION

This study was conducted to determine whether children with Tourette's Syndrome exhibit an identifiable pattern of test performance on standardized psychological measures, and whether this pattern of performance could distinguish them from LD students, a group which TS students could resemble. In order to make this determination, a group of TS students was assembled and a group of LD students matched on the bases of functional ability level and age. These groups were administered a battery of psychological and educational tests, and the results were statistically analyzed.

Generalizability Limitations

Because TS is a low incidence exceptionality, the sample used in the current study was, necessarily, small. A great deal of effort was required to locate and to attain consent for participation from the 25 TS subjects who were included in the study. The TS group is a "convenience sample"; one comprised of TS subjects agreeing to participate in the study. The small sample size has a greater impact upon the generalizability of the results. A larger sample would have increased the power of the results attained. However, Tourette's Syndrome represents a severe impact upon individuals with the disorder, and any research of the characteristics of any size sample of TS children holds significance because of the severity and debilitating effects of the syndrome.

Another problem in the generalizability of the results has to do with the variation of symptoms characteristic of the syndrome and the effects of medication. As noted, the severity of symptoms in TS can vary over days or months. In addition, the types of symptoms can vary over the course of the syndrome. The effects of medication also alter the severity of the symptoms. As a consequence, the results may not be fully applicable to all TS subjects. However, there are a number of characteristics found in this study which have been found in other studies of children with TS.

Children with learning disabilities also express their problems in a variety of ways, such as in problems with attention, concentration, task completion, reading, spelling, or arithmetic. As a consequence, the LD population is also not necessarily homogeneous. The small sample included in this study may not be totally representative of the "average" LD child. However, actually, there is no "average" LD child, and therefore the children included here probably represent other LD students.

Although these limitations to generalizability were present, the results do hold value because of their ability to present general characteristics which TS students possess. Consequently, the information obtained reflects characteristics of many TS and LD students, and therefore is potentially useful to school psychologists and other educational professionals.

Evaluation of Research Question

The major purpose of this study was whether the psychological test performance of TS students could differentiate them from LD students. In addition, an attempt was made to describe characteristic patterns of performance, if present. The research question posed was whether performance on the psychological and educational measures could differentiate between TS and LD children.

In answer to this question, the two groups could not be differentiated solely on the basis of the psychological tests used. Significant *t*-test values were found on seven of the scales, including the Information, Vocabulary, Block Design, Coding, PPVT-R (receptive language), Reading, and Spelling. However, given the large number of scales examined (i.e., 29), a few significant differences would be expected on the basis of probability (i.e., as statistical artifacts). Therefore, a strong pattern of differences was not found.

The TS group's performance on the tests did differ from the average test performance reported in the test manuals. In relation to ability level, the WISC-R Full Scale IQ mean score for the TS group was 108.00, while the test mean is

100. Within the WISC-R scales, the majority of the TS subtest mean scores were also above the mean scaled score of 10. However, the TS group demonstrated relative weaknesses on the Arithmetic and Coding subtests. On the VADS, only their Visual-Oral and Visual-Written subtest mean scores were at or above the 50%ile. All other VADS subtest mean scores for the TS group were near or below the 40%ile, with their Total VADS score at the 38.56%ile. On the other tests, their Receptive Language was relatively commensurate with general ability level, with a mean score on the PPVT-R of 105.24. Likewise, the Reading and Spelling subscales of the WRAT were commensurate with their ability level (i.e., Full Scale IQ on the WISC-R), with mean scores of 104.88 and 105.68, respectively. Their Arithmetic mean score on the WRAT was lower than expected relative to their Full Scale IQ on the WISC-R.

This group of TS children demonstrated competent intellectual abilities, which in general were above the mean for children their age. However, the group demonstrated weaknesses in short-term memory (particularly auditory input and oral expression), psychomotor speed (visual-motor dexterity and speed), written arithmetic, and visual-motor skills.

For the LD group, ability level was matched for the TS group. The mean Full Scale IQ for the LD group was 107.08, with relatively equal Verbal (103.68) and Performance (105.60) mean scores. A review of subtest performance for this group showed slightly lower mean scores on the Information and Arithmetic subtests. Short-term memory for visual and auditory stimuli were consistently between the 40%ile and 50%iles, with their Total VADS mean score at the 42.50%ile. Also, their Receptive Language mean score was below the corresponding mean Full Scale IQ. In addition, all of their achievement test mean scores were below the Full Scale IQ.

The LD group also demonstrated weakness on the BVMGT, with their visual-motor skills 13.64 months below average age expectations.

A number of trends in the comparison of these groups emerge. Table 14 summarizes the relative weaknesses of the two groups. Both the TS and LD groups demonstrated similar, lower scores in numerical reasoning, short-term memory, written arithmetic, and visual-motor skills. There were, however, some differences. The TS group demonstrated lower scores in oral expression, written expression, and intrasensory integration. The LD group demonstrated lower scores in a more generalized fashion, including receptive language, reading (i.e., word recognition, sight vocabulary), and spelling.

TABLE 14

RELATIVE WEAKNESSES OF THE TOURETTE'S SYNDROME AND LEARNING DISABLED GROUPS

TS Group	Learning Disabled Group
Common Weaknesses	
1. Arithmetic (WISC-R)	1. Arithmetic (WISC-R)
2. Total VADS	2. Total VADS
3. Written Arithmetic (WRAT)	3. Written Arithmetic (WRAT)
4. Visual-Motor (Bender)	4. Visual-Motor (Bender)
Differences	
	1. Receptive Language (PPVT)
	2. Reading (WRAT)
	3. Spelling (WRAT)

Conclusions and Interpretations

This study of TS and LD students did show that both groups have significant weaknesses in areas measured by commonly used psychological tests. However, weaknesses were similar (i.e., mental and written arithmetic, short-term memory, and visual-motor skills). In addition, the magnitude of these significant differences was not large enough to clearly distinguish the two groups. Although the LD group did show additional weaknesses in receptive language, reading and spelling, the tests used could not clearly discriminate between the two groups.

Although the psychological tests used could not differentiate the two groups, there is evidence that the TS group may demonstrate a more isolated pattern of impairment than the LD group. In consideration of the *t*-test differences between the groups, the TS group scored higher on tests of general information and long-term, remote memory, verbal knowledge, fluency and expressiveness, visual analysis and synthesis, receptive language, reading recognition, and spelling. In contrast, the TS group scored lower on a test of psychomotor speed, attention, and concentration.

The group of TS subjects who participated in the study had a higher mean WISC-R Full Scale IQ than the comparison group reported in the test manual. The TS group mean is more than one half of a standard deviation above the test mean of 100. On the average, verbal and performance abilities were balanced in the TS group. The higher mean IQ may be due to the small sample or to the nature of the TS subjects. This group was primarily recruited with the help of the local TS support group. Membership in this group was a common factor for the majority of participants, and may be related in some way to a higher level of performance on the WISC-R scale. Ability level scores above average for TS children are also reported in the literature. For example, Sutherland et al., (1982) obtained a mean Full Scale IQ of 106 (N = 32), and Hagin et al., (1982) obtained a mean IQ of 110 (N = 10) on the WISC-R. The Sutherland study involved clinic patients, and the Hagin study involved students recruited by the Tourette's Syndrome Association. The current study finds a comparative ability level which is slightly above average, perhaps because the general memberships of these TS groups are, on the average, slightly more intellectually competent.

The statistical results should also be reviewed in consideration of the nature of learning disabilities. As noted in Chapter 1, the term "learning disability" refers to a child with a deficit in one or more of the primary learning areas (such as math, reading, or spelling), combined with a discrepancy between intellectual ability and academic achievement. As such, the term covers a large group of children with a variety of problems. This variety is reflected in the population studied. That is, the LD group was selected on the basis of matched age and ability level and no attempt was made to control the types of learning problems for the group. This is reflected in their performance on the tests. Their average WISC-R Full Scale IQ fell well within the "average" range and their Verbal and Performance mean scores were relatively balanced. However, they did show lower scores in receptive language, reading recognition, spelling, and arithmetic.

When compared statistically, significant differences were noted between the two groups in receptive language, reading recognition, and spelling. The difference in written arithmetic did not attain statistical significance, primarily because both groups showed a relative weakness in this area. These results indicate that, on the average, the learning disability group had a more generalized, or non-specific, pattern of academic achievement deficit. This group (by definition) may have difficulties in a number of different areas, such as reading, spelling, or arithmetic. In contrast, the TS group shows more specific weakness in academic achievement (e.g., written arithmetic). This characteristic also has been noted in earlier studies. For example, Incagnoli and Kane (1982) found in a study of 13 TS children that arithmetic performance on the WRAT was two years below current grade-placement. Bornstein, King, and Gordon (1983) and Joschko and Rourke (1982) also note poor written arithmetic abilities in studies of seven and three TS children, respectively.

One characteristic of TS student performance mentioned by researchers (e.g., Hagin, Beecher, Pagano, & Kreeger, 1982) is difficulty in sustained handwriting, such as mathematics computation or written language. Although not statistically lower than the LD group, written arithmetic on the WRAT for the TS group was a relative weakness when compared to the WISC-R Full Scale IQ. This weakness was, however, statistically significant on the Coding subtest of the WISC-R. On this test, the child is required to copy symbols at a rapid pace over a two-minute period. For the TS student, sustained attention and concentration are difficult. When difficulties in the visual-motor area are added (e.g., from the BVMGT results), this task becomes even more difficult for the TS student.

Incagnoli and Kane (1982) noted problems in Coding, written arithmetic, and copying tasks, similar to the difficulties noted in the current study. They commented that these "represent a dysfunction of nonconstructional visuopractic abilities" (p.308). They also note that these deficits are visuographic in nature.

Visual construction tasks were a strength of the TS group in this study. On the Block Design subtest, the TS group scored significantly higher than the LD group. Their Object Assembly score, although not statistically significantly different from the LD group, was above average, with a mean of 11.88. These visual construction abilities are in contrast to their weaknesses noted in Coding and on the BVMGT. It may be that when the stimuli are more meaningful (even if abstract), the TS children perform more effectively. This may also be influenced by a degree of concentration, (i.e., interest and absorption in the task) where TS symptoms are noted to be reduced when anxiety is reduced.

Another characteristic of the TS group was significantly higher scores in Information and Vocabulary. The Information subtest is influenced by a number of factors, such as the richness of the environment and alertness to the environment. It also involves long-term, remote memory, a factor which may have been significant here. The performance of the TS group was generally below the mean on the VADS test of short-term memory. This was particularly so in auditory memory, whereas visual memory appeared relatively intact. Short-term memory may be affected by attentional factors, particularly in the auditory area. In contrast, the TS group may not be affected in the long-term memory area, where information is "overlearned". The Vocabulary subtest is influenced by verbal knowledge and fluency, and also by environmental factors. Verbal expressiveness is a significant strength for the TS group when compared to the LD group.

Implications

The results of this study indicate that school psychologists cannot identify TS students solely on the basis of test performance on commonly used psychological tests. Practitioners will recognize that learning difficulties are present in TS students, but they will be unable to determine the presence of TS based upon the psychological test performances of the children. Practitioners should be alert to the early symptoms of TS, primarily motor and phonic tics. These symptoms should be followed up by the appropriate medical referral for diagnosis, and to rule out other disorders.

Although the psychological tests used in this study were not able to demonstrate a clear and strong pattern of deficits which could differentiate TS from LD students, a number of characteristics of the TS group performance did emerge. These weaknesses in visiographic abilities were also noted in prior research. As noted by Incagnoli and Kane (1982), there is evidence for a visiographic deficit, whereas visioconstructive abilities are intact. From a theoretical standpoint, the findings here reinforce the idea that this deficit exists. In addition, the visual construction tasks (i.e., Block Design and Object Assembly) are intact, especially in comparison to the lower scores in Coding and on the BVMGT. These findings therefore build on prior research and support the theoretical interpretations. Incagnoli and Kane also note that these deficits are "typically considered to be cortical deficits, [but] it is unknown whether these impairments are secondary results of neuropsychological irregularity of the basal ganglia, or whether they are manifestations of a primary lesion of the cerebral cortex" (p.308).

In further research, it will be necessary to determine why these differences exist between the TS group and others. As the size of samples increase to support these findings, researchers may begin to explore the nature of these visiographic deficits. As noted earlier, TS students may have problems in attention and concentration during sustained, rote activities where these visiographic abilities are used. In contrast, when the task is more stimulating and interesting, their performance may improve significantly. In addition, further research should direct attention to finding ways to facilitate learning for the TS student. These areas may be fruitful for future research.

Educators and psychological practitioners should be made aware of the body of research available on the academic and test performance of TS students. If this were done, it could facilitate an earlier diagnosis and treatment, and avoid potential misdiagnosis. An understanding of typical strengths and weaknesses could also lead to more appropriate investigation of individual characteristics and appropriate educational approaches.

The TS group demonstrates characteristics which could inhibit their educational performance. Hagin et al. (1982) noted that the TS students in their study had problems in expressing their learning, particularly where independent reading and sustained handwriting were involved (e.g., mathematics computation and written language). The TS group here had problems in psychomotor speed (e.g., attention and concentration) and written arithmetic.

The TS group would benefit from interventions and changes in classroom structure to accommodate these problems. First, these students could be allowed to express their learning in alternative ways. Whereas the TS group showed a weakness in sustained attention for written work (i.e., Coding), they also showed a strength in verbal knowledge and fluency (i.e., Vocabulary). The goal may be to eventually increase the student's ability to sustain attention over time, and to increase the rate at which written work is completed. However, another method may be to allow the student to express learning through verbal communication. Because of their difficulty with written work, TS students also would benefit from shorter written assignments. General principles of learning theory can apply here. Small bits of information, combined with reinforcement can be successful with the TS student. In addition, the work should be meaningful and stimulating for the student. Where written work is involved, the TS student may require help in organization, perhaps with a system of outlining or mental planning before the work takes place.

In addressing the educational services to be provided TS students, Joschko and Rourke (1982) do remind us that "any form of psychological or scholastic intervention designed for them [should] be based on the same principles that are used for any other group of children" (p.303). As with any group under study, the average performance pattern is often quite different from the individual performance. The TS student should be allowed to function to the best of his or her abilities within the academic setting. However, educational and psychological practitioners can assist when the student experiences difficulty by appropriate assessment and remediation procedures.

Recommendations

Although TS is a low incidence disorder, the syndrome is significant because of the severity and nature of the symptoms. The study of TS can lead to recommendations concerning the theoretical and practical aspects of the problem.

From a theoretical standpoint, it was found in this study that visiographic problems (low Coding and written arithmetic) do exist, and these findings reinforce prior studies. Because visual construction tasks (Block Design and Object Assembly) are intact, this problem can be further isolated. This type of problem, whether a problem of sensory-motor performance or integration lends support to the theory of CNS involvement. While the LD group demonstrated a generalized pattern of academic weakness, the TS group demonstrated a more specific weakness in written arithmetic. This supports TS as a discrete problem with it's consequences in a specific cluster of academic performance skills. Based on these results, the existing theoretical formulations are supported.

There are also recommendations for future research. First, the problems noted in visiographic abilities should be explored. The question here is whether these are sensory-motor, integration, or attentional problems. Further research could attempt to separate these issues. In a practical manner, further research could investigate what types of interventions would be most successful in remediating these difficulties. These interventions might include instruction in the organization of written work, reinforcers for improved performance, or modifications in the type and length of assignments.

Recommendations for training include increasing an awareness of the symptoms, nature, and problems of TS students. Because TS is a low incidence disorder, an awareness of the diagnostic symptoms is also a necessary aspect of training.

Last, some recommendations for practice are also significant. General recommendations include the use of knowledge of TS to make early identification and referral a reality. Demographic studies have indicated that the majority of TS subjects were misdiagnosed initially. If practitioners and educators increase their knowledge of TS, this could facilitate appropriate diagnosis and referral.

Summary of Results and Findings

The results of this study indicated that, although TS students do display a pattern of weaknesses, they cannot be differentiated from LD students on the basis of psychological tests alone. School psychologists and other professions should be educated and aware of the symptoms and course of TS. Through this awareness, these professionals can be alert to the early signs of TS, and make referral to a physician for treatment, as well as initiate social and educational interventions to assist the student.

Although TS and LD students both demonstrated academic problems, the TS group showed a somewhat more isolated pattern of abilities and deficits. Specifically, the TS group showed weaknesses in mental and written arithmetic, short-term memory, and visual-motor skills. Tasks involving sustained attention and handwriting may be particular problems. Because of this, modifications in the educational program may be necessary. For example, learning may be demonstrated in shorter assignments, or breaks may be necessary. Further research in this area should direct attention toward the effectiveness of social and educational interventions for TS students.

APPENDIX A

PARENTAL CONSENT FORM

PARENTAL CONSENT FORM

I am a School Psychologist researching Tourette's Syndrome. The study I am conducting is comparing the psychological test performance of children with Tourette's Syndrome to students with learning disabilities. For this purpose, I am attempting to secure permission from parents to review your child's student records (if testing has occurred in the past), or to test your child, in or out of school. If you agree to testing, the following battery will be administered, assessing the following areas:

General Intelligence	Wechsler Intelligence Scale for Children.
Academic Ability	Wide Range Achievement Test
Receptive Language	Peabody Picture Vocabulary Test
Short Term Memory	Visual Aural Digit Span Test
Visual-Motor Skills	Bender Visual-Motor Gestalt Test

This testing will be:
*free of charge
*at the convenience of your family, either in school or out
*completely confidential

A brief consultation concerning the test results will be available to you at your request. However, these test results will not be made available to the school system or other agencies unless you request this in writing. The results of individual testing will be examined in a group fashion, and no individual children will be identified.

If you agree to participate in this study, please check one or more of the boxes below, and return this form to the address below.

==

I will allow the School Psychologist named below to perform the following checked activities:

____1. Examine and anonymously record my child's latest psychological test results.
____2. Take my child out of the classroom for not more than two hours of testing.
____3. Test my child outside of school (I prefer not to have him/her miss class).
____4. Please contact me to provide further information.

____________________________ ____________________________
Child's Full Name Parental Signature Date

APPENDIX B

BENDER VISUAL-MOTOR GESTALT TEST AGE EQUIVALENT TRANSFORMATION TABLES

BENDER VISUAL-MOTOR GESTALT TEST
AGE EQUIVALENT TRANSFORMATION TABLES

KOPPITZ SCORING

Error Score	Age Range	Median Age (Months)
0	11-0 to 11-11	138 months
1	10-0 to 10-11	126 months
2	9-0 to 9-11	114 months
3	8-6 to 8-11	104 months
4	8-0 to 8- 5	99 months
5	7-6 to 7-11	92 months
6	7-0 to 7- 5	87 months
7	6-6 to 6-11	80 months
8	6-0 to 6- 5	75 months
9	5-9 to 5-11	70 months
10	5-6 to 5- 8	67 months
11	5-4 to 5- 5	64.5 months
12	5-2 to 5- 3	62.5 months
13	5-0 to 5- 1	60.5 months

Note: No error scores exceeded 13 for any of the students tested.

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BIOGRAPHICAL SKETCH

Richard Trifiletti was born in Portchester, New York, and raised in Clearwater, Florida. He received his Bachelor of Arts and Master of Arts degrees from the University of North Florida in 1976 and 1978 respectively. He is currently employed as a school psychologist with the Duval County School System in Jacksonville, Florida.

Richard is married to the former Katherine Elliot Barnes, with three children; Richard, Philip, and Daniel.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Larry C Loesch

Larry C. Loesch, Chairman
Professor of Counselor Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Robert Drummond

Robert Drummond
Professor of Counselor Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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